

# A REVIEW OF THE NEOTYPIFICATION OF *ASTROPHYTUM CAPRICORNE* VAR. *CRASSISPINUM* (H. MÖLLER) OKUMURA (CACTACEAE)

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## ABSTRACT

We review Momberger's (2007) designation of a neotype for *Astrophytum capricorne* var. *crassispinum*. The morphological evidence indicates that the neotype (ULM-18572) seriously conflicts with Heinrich Möller's (1925) original description of this taxon. Momberger's assertion that the *Astrophytum* population from Sierra Agua Chiquita, Coahuila, Mexico, is var. *crassispinum* is incorrect. Under the provisions of ICBN, Article 9.17b, we recommend that ULM-18572 be set aside and superseded by another element. We designate ZSS-019963 as the neotype for var. *crassispinum* for its morphology agrees with the original description.

## RESUMEN

Se revisa la designación de Momberger (2007) de un neotipo de *Astrophytum capricorne* var. *crassispinum*. La prueba morfológica indica que el neotipo (ULM-18572) está en serio conflicto con la descripción original de Heinrich Möller (1925) de este taxón. La afirmación de Momberger de que la población de Sierra Agua Chiquita, Coahuila, México, es var. *crassispinum* es incorrecta. En virtud de lo dispuesto en el ICBN, Artículo 9.17b, se recomienda que ULM-18572 debe rechazarse y ser reemplazado por otro elemento. Designamos ZSS-019963 como neotipo para la var. *crassispinum* pues su morfología está de acuerdo con la descripción original.

## ZUSAMMENFASSUNG

Wir überprüfen Momberger's (2007) Bestimmung eines Neotypus für *Astrophytum capricorne* var. *crassispinum*. Die morphologischen Daten zeigen, dass der Neotypus (ULM-18572) ernsthaft in Konflikt mit Heinrich Möller's (1925) Original-Beschreibung dieses Taxons steht. Momberger's Behauptung, dass die *Astrophytum* Population der Sierra Agua Chiquita, Coahuila, Mexiko, die var. *crassispinum* sei, ist falsch. Nach den Bestimmungen des ICBN, Artikel 9.17b, empfehlen wir, ULM-18572 aufzuheben und durch ein anderes Element zu ersetzen. Wir bezeichnen ZSS-019963 als Neotypus für die var. *crassispinum* da seine Morphologie mit der Original-Beschreibung übereinstimmt.

KEY WORDS: *Astrophytum*, botany, Coahuila, Cuatro Cienegas, taxonomy

## INTRODUCTION

In 1925, Heinrich Möller described *Echinocactus capricornus* var. *crassispinus* [sic] based on a series of specimens collected by his brother, Arthur Möller, who resided in San Pedro de las Colonias, Coahuila, Mexico. The original series collected by Arthur Möller was shipped to Heinrich Möller for purposes of study and description. About half of the plants in the original series had sparse, irregularly scattered woolly flecks on the epidermis; the remaining plants were completely nude and green. The spines were very stout, somewhat flattened, and numbered from 6 to 8 per areole. The flower was described as canary yellow with a sulfurous yellow throat. The number of specimens in the original series was not mentioned and no photographs accompanied the original description. Furthermore, Heinrich Möller did not designate a holotype nor did he state if any specimens from the original series were deposited in a herbarium. The absence of such information, as well as the failure to find this plant at the type locality (see below) set the stage for a decades-long debate (*fide* Momberger 2007) concerning the existence and identity of this taxon.

The type locality of Möller's var. *crassispinum* was given as the Sierra de Parras, but no collector has ever found plants matching the original description in that mountain range. Through the efforts of many collectors, the occurrence of *Astrophytum capricorne* var. *senile* in the western part of the Sierra de Parras has been well documented (Hoock 2008, and references therein). It also occurs in the Sierra Baicuco (= Sierra de las Buras, Sierra de la Peña) and Cerro Bola, but not yet recorded from the small outlier range, the Sierra Mayran. Farther



east, in the region near Parras de la Fuente, Říha and Bušek (1986) reported the occurrence of *Astrophytum capricorne* var. *capricorne* (A. Dietr.) Britton et Rose.

In 1930, the eminent cactus collector, H.W. Viereck, discovered an *Astrophytum* in the vicinity of Cuatro Cienegas, Coahuila, Mexico (Bernhard & Hooek 1986). The collected specimens belonged to the *capricorne* group, but differed from the type species in having stout, flattened spines (usually 6 to 8 per areole), a large stem size (a maximum of 50 cm in height), and an epidermis densely covered with short, white hairs (trichomes) having a felt-like texture. Viereck's discovery was obviously morphologically similar to the previously described var. *crassispinum*. Kayser (1933) described and named the population from the vicinity of Cuatro Cienegas as *Echinocactus capricornis* var. *niveus*.

In 1933, plants identified as *Astrophytum capricornus* var. *crassispinus* [sic] were featured on postcards created by Otto Stoye. The postcard photographs included both nude and sparsely flocked specimens from the private collection of Kurt Kreuzinger (Hooek 2008:162). Our examination of the postcards led us to conclude that the plants were very similar to those described by Heinrich Möller in 1925. The plants may have been imported from Coahuila by A.V. Fric, who was a known associate of K. Kreuzinger, but the precise locality information was never published.

In 1985, a locality for "crassispinum-like" plants in "northern Coahuila" was discussed in an *Astrophytum* "ring letter" which included a photograph of the habitat. Ulrich Bernhard and Heinz Hooek searched for, and found the locality by matching the mountains in the photo with the actual mountain range on the landscape. The locality was situated approximately 42 km west of Cuatro Cienegas; the habitat and its plants were described by Bernhard and Hooek (1986). The authors reported that densely flocked, white plants (var. *niveum*) and totally nude, green plants (which the authors called the "nude form" of *Astrophytum capricorne* var. *niveum*) occur together in the habitat in approximately equal numbers. But intermediate (sparsely flocked) plants were encountered only very sporadically (Fig. 1). Similar observations concerning the relative abundance of flocked, nude and sparsely flocked plants were also reported by Baumann (1992). Although no quantitative data were presented, the sporadic occurrence of sparsely flocked plants was surprising considering the likelihood of cross-pollination between the white and green forms. Říha and Bušek (1986) described variation in the spine morphology and epidermal flocking of these *Astrophytum* from the locality west of Cuatro Cienegas. The authors noted, aside from the typical var. *niveum*, several forms including nude plants with white, yellow, and dark brown spines and yellow flowers.

Various authors, including Megata (1944), Haage and Sadošský (1957 a,b), Sadošský and Schütz (1979), Ito (1981), and Bušek (1981) regarded the nude and sparsely flocked plants with stout spines as "crassispinum". It could not be determined whether the plants illustrated by these authors originated from a single locality or from several different localities, or if any came from 42 km west of Cuatro Cienegas. Říha and Bušek (1986), Bernhard and Hooek (1986), Baumann (1992), Hooek and Kleszewski (2006), and Hooek (2008) all indicated that the nude plants from west of Cuatro Cienegas were morphologically similar to Möller's *crassispinum*.

In 2007, Momberger reported the surprising discovery of the "missing" *Astrophytum capricorne* var. *crassispinum*, claiming that this taxon occurs along the western slopes of the Sierra Agua Chiquita. This mountain range is a northern extension of the Sierra de la Purisima which forms the eastern margin of the Bolson de Cuatro Cienegas. The latter is nearly divided into eastern and western basins (bolsons) by the Sierra San Marcos. Momberger accorded this *Astrophytum* population formal taxonomic recognition as *Astrophytum capricorne* subsp. *senile* var. *crassispinum* and designated a neotype (ULM-18572) which was deposited in ULM (Herbarium Universität Ulm, Germany).

Pavliček (2011) subsequently described the Sierra Agua Chiquita population of *Astrophytum* as a new subspecies, *Astrophytum capricorne* (A. Dietr.) Britton et Rose subsp. *sanjuanense*. He designated a section of a rib with spines as the holotype: PR 745389, Department of Botany of the National Museum, Praha (Prague), Czechoslovakia.

As a consequence of Momberger's discovery, there are now two *Astrophytum* populations that potentially qualify as Möller's var. *crassispinum*. We review the morphological data pertaining to the eastern and western



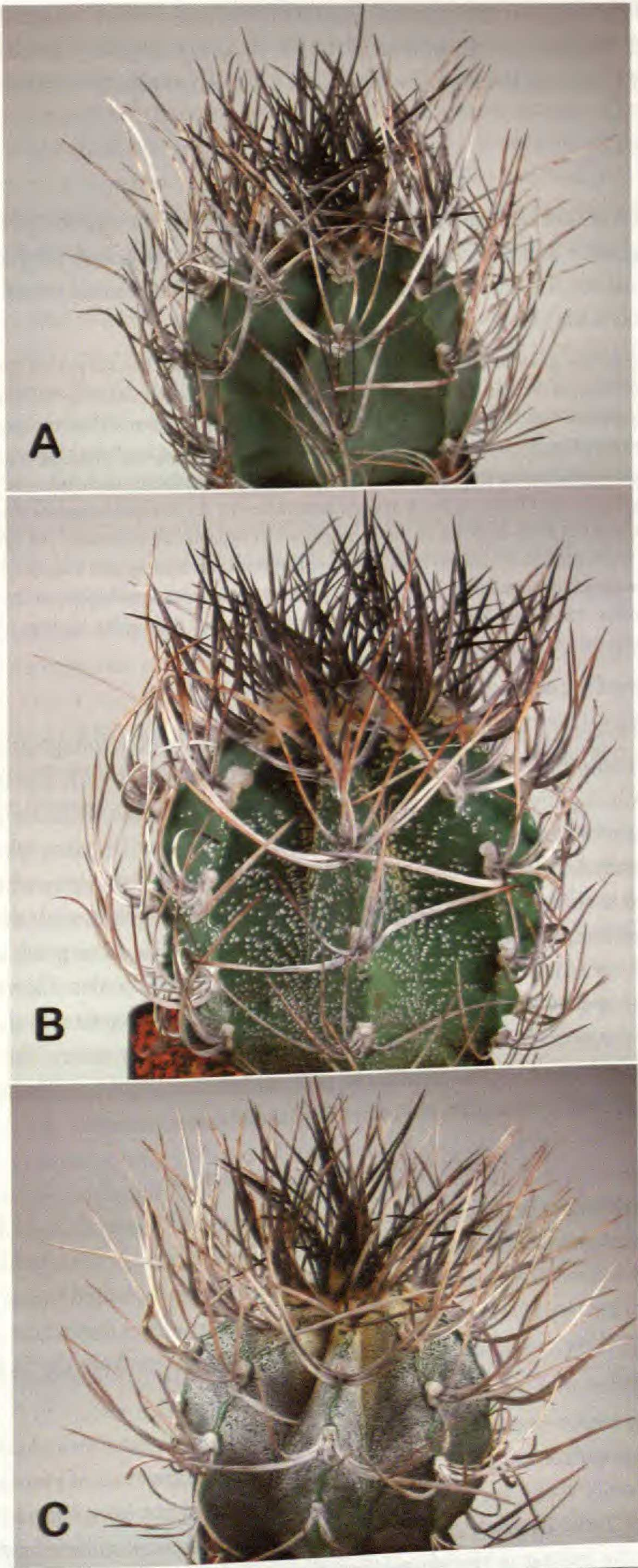


FIG. 1. Examples of (A) the completely nude, (B) sparsely flocked, and (C) densely flocked *Astrophytum* plants from the locality 42 km W of Cuatro Ciénegas, Coahuila, Mexico.



bolson populations of *Astrophytum* and compare them with Heinrich Möller's original description. Our purpose is to determine if Momberger's recognition of the Sierra Agua Chiquita population as var. *crassispinum* and his designation of a neotype for this taxon should be accepted or rejected under the provisions of ICBN Article 9.17.

#### ORIGINAL DESCRIPTION

The original description of *crassispinum* by Heinrich Möller (1925) is quite explicit, presenting morphological information on the vegetative and generative traits of this taxon. In our opinion, the potential of attaching this name to a natural population has always existed owing to the completeness and detail of Möller's description. The original description reads as follows:

Körper einfach, kugel- bis kegelförmig, 15 cm hoch, 8–9 cm im Durchmesser, laubgrün. Der Körper bei der einen Hälfte der erhaltenen Pflanzen ist absolut nackt, der Körper der anderen Pflanzen ist mit spärlichen, regellos zerstreuten Wollflockchen bedeckt. Der Scheitel wenig eingesenkt, mit wenig gelbem Wollfilz versehen. Rippen stets 8, scharfkantig. Areolen 20 mm voneinander entfernt, länglich, bis 6 mm gross, mit reichlich gelblichen Haaren, die später vergrauen und verfilzen. Stacheln 6, höchstens 8, plattgedrückt, sehr dick, in der Jugend braunschwarz, später grauweiss, kreidig. Das unterste Paar ist am stärksten, bogenförmig nach links und rechts von der Pflanze abstehend, die Spitze nach oben gebogen. Die Pflanze ist durch das sehr lockere Gewirr der Stacheln umgeben, da dieselben nicht abgebrochen oder bestossen werden. Blüten in der Nähe des Scheitels, ca. 6 cm gross. Der Fruchtknoten schlank, mit spitzigen Schüppchen bedeckt. Blütenröhre mit reichlicher Wolle. Blütenhülle trichterförmig. Äussere Hüllblätter schmutzig gelb, zugespitzt; innere spatelförmig, gezähnt, kanariengelb, seidenglänzend. Der Schlund der Blüte ist nicht karminrot, sondern schwefelgelb, wachsartig. Die Staubgefässe kaum halb so lang wie die Blütenröhre. Fäden gelb, Beutel etwas dunkler. Der Stempel hat 8 hellgelbe Narben und überragt die Staubgefässe. Frucht und Samen wie beim Typ und den anderen Varietäten.

Our English translation of the original description reads as follows:

Body simple, spherical to conical in shape, 15 cm high, 8–9 cm in diameter, foliage-green. The body of half of the obtained plants is completely naked; the body of the others is covered with sparse, irregularly scattered woolly flecks. The apex is slightly depressed, covered with a little yellow felt. Ribs are always 8, sharp-edged. Areoles are 20 mm apart, oblong, to 6 mm in size, with abundant yellowish hairs, which later turn gray and dingy. Spines 6, maximally 8, flattened, very thick, black-brown in youth, later gray-white, chalky. The bottom pair is strongest, bowed to the left and right and standing away from the plant, with the tips curved upwards. The plant is surrounded by the loose tangle of spines which do not break off or prick each other. Flowers are near the apex, about 6 cm tall. The ovary slender, covered with pointed scales. Flower tube with abundant wool. Perianth funnel-shaped. Outer tepals acuminate, dirty yellow; inner tepals spatulate, denticulate, canary yellow and satiny. The throat of the flower is not crimson, but sulfur-yellow, waxy. The stamens barely half as long as the corolla tube. Filaments yellow, anthers slightly darker. The pistil has 8 bright yellow stigma lobes and towers above the stamens. Fruit and seeds as in the type and other varieties.

#### MORPHOLOGICAL COMPARISONS

Morphological comparisons of the *Astrophytum* population from the western bolson (42 km west of Cuatro Ciénegas), and the Sierra Agua Chiquita population from the eastern bolson, with Möller's (1925) original description are presented below. Comparative data are drawn from the published literature, but the published information is supplemented by our direct observations of these plants from the habitat and from horticultural material. In comparing Möller's original description with the *Astrophytum* from the Sierra Agua Chiquita, the following points are made:

- 1) The plants studied by Möller consisted of completely nude as well as sparsely flocked plants in nearly equal proportions. The population from the Sierra Agua Chiquita is comprised of plants having sparse, irregularly scattered woolly spots, but completely nude plants have not been found (Hooek & Kleszewski 2006; Momberger 2007; Pavlíček 2011). Furthermore, as far as we can determine, none of the several persons visiting the habitat in the Sierra Agua Chiquita (F. Gottschlich, F. Jahn, K.P. Kleszewski, P. Pavlíček, W. Sporbert) has ever reported finding completely nude plants.
- 2) Möller (1925) described the new spines of *crassispinum* as having a black-brown color, turning gray-white



with age. But, Momberger (2007) described the new spines as straw-colored in the plants from the Sierra Agua Chiquita. Hooek and Kleszewski (2006) also described the plants from this mountain range as having new spines with a golden-yellow hue, becoming dirty gray with age. Pavlíček (2011) described the new spines as gray-yellow, the older spines being predominantly gray in color and slightly frayed. In culture, we have noted some plants with reddish brown spines. However, such plants are the exception; the most common color is golden yellow or straw-colored. If Möller had observed any plants in his original series with yellow spines at the stem apex he would have certainly mentioned it. Significantly, there are no reports of plants from the Sierra Agua Chiquita with new spines of a black-brown color.

- 3) In Möller's original description of *crassispinum*, the spines are described as "flattened" and "very thick," 6 to 8 per areole. According to Momberger (2007) the plants from the Sierra Agua Chiquita have 6 to 8 (–10) spines. Pavlíček (2011) gave a slightly higher number, stating there are always more than 8, and usually 10 to 12 spines. According to Möller (1925) the bottom pair of spines is strongest, bowed to the left and right and standing away from the plant, with the tips curved upwards. In plants from the Sierra Agua Chiquita, this trait is only weakly expressed. Momberger (2007) stated that the bottommost pair is mostly flattened and the upper spines mostly round. Pavlíček (2011) described them as flexible, slightly angular, and in some specimens almost triangular. He stated that they are only slightly stronger than in the subspecies *senile*. Direct comparisons reveal that the spines of the Sierra Agua Chiquita plants are not as stout as those of the plants from the western Bolson de Cuatro Cienegas, but compare favorably with the spines of var. *aureum* from the Sierra de la Paila (Fig. 2).
- 4) The blossoms of the *Astrophytum* from Sierra Agua Chiquita are yellow with a red throat, but the red color is usually reduced, and in exceptional specimens the throat is pure yellow, brownish or honey-yellow (Hooek & Kleszewski 2006; Momberger 2007). Pavlíček (2011) described the flower throat as reddish-brown, brown-yellow or pure yellow. Only the yellow-throated specimens agree with Möller's original description of the flowers.

Momberger's assertion that the plants from the Sierra Agua Chiquita are the missing *crassispinum* may have been influenced by photos published in Haage and Sadovský (1957b) and Sadovský and Schütz (1979). We acknowledge that the photos show close agreement with the *Astrophytum* from the Sierra Agua Chiquita (see Fig. 3 for a comparison). However, a critically important point must be made here. The published photos are not of the original material collected by Arthur Möller. They represent plants collected by H.W. Viereck and sent to Brno, Czechoslovakia, and credited to Konrad Kayser and Sadovsky himself (Sadovský & Schütz 1979:152). Therefore, Momberger's statement that the photos depict the "real" *crassispinum* is unsupported and clearly in error.

We are of the opinion that the plants described by Momberger conform generally well to a population of *Astrophytum capricorne* var. *aureum* characterized by prominent, but sparse, white spots on a green or bluish-gray-green epidermis. Our taxonomic concept follows that suggested by Hooek and Kleszewski (2006). However, we are prepared to defer to Pavlíček's (2011) taxonomic conclusion that the Sierra Agua Chiquita population represents a new subspecies, although obviously related to the var. *aureum* populations from the Sierra de la Paila.

A comparison of the plants from the western bolson (42 km west of Cuatro Cienegas) with Möller's original description is presented below. As previously stated, we draw upon published information as well as direct observations of plants in habitat and culture. The following points are made:

- 1) The original material collected by Arthur Möller included completely nude and sparsely flocked plants. The populations west of Cuatro Cienegas include completely nude, sparsely flocked, and densely flocked plants. While the presence of nude and sparsely flocked plants is consistent with the specimens comprising the original series, the presence of densely flocked (var. *niveum*) plants is problematic, and requires further discussion (see below, *Remarks on Type Locality*).
- 2) New spines emerging from the apex of the stem are usually black-brown in color, becoming gray-white with age, and hence agree with Heinrich Möller's original description.
- 3) The original description of *crassispinum* states that the spines are "flattened" and "very thick", numbering 6 to 8 per areole. The bottom pair of spines is strongest, bowed to the left and right and standing away from



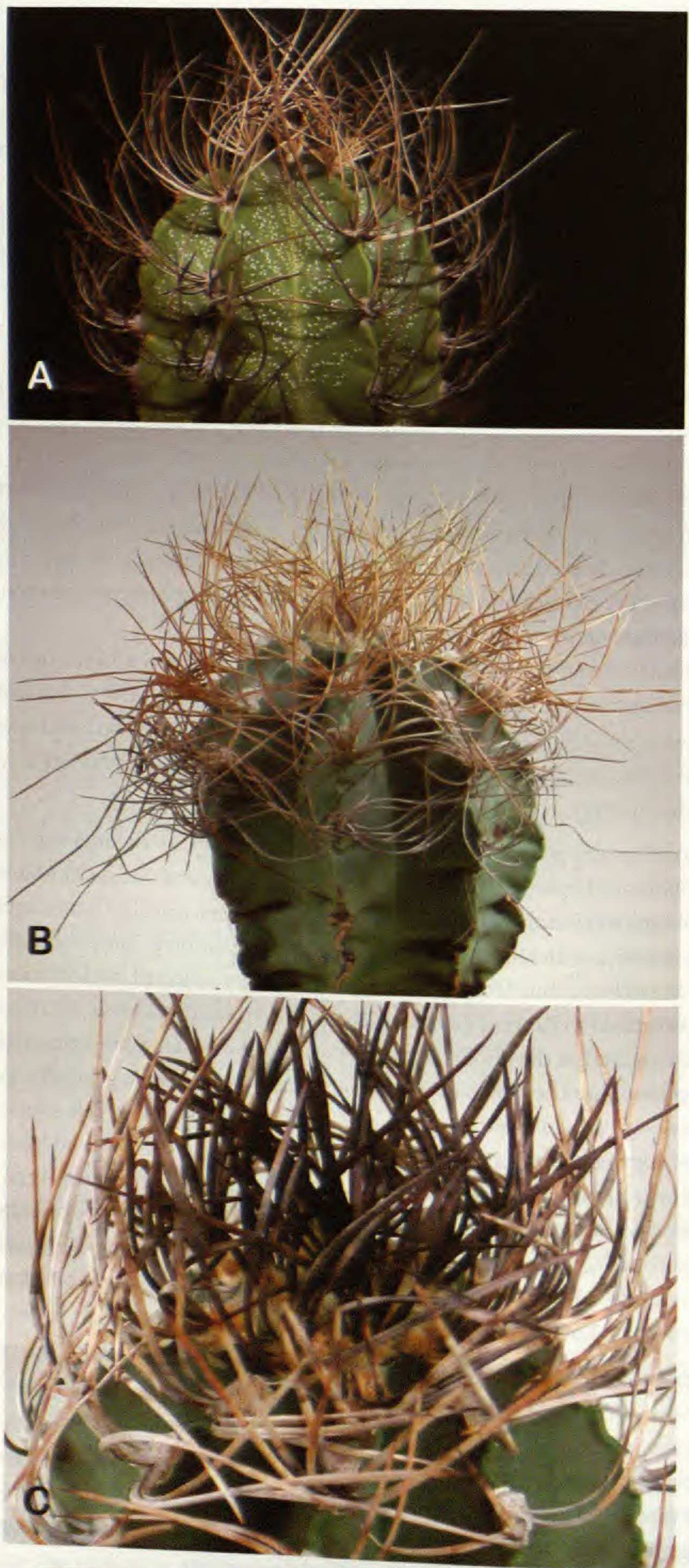


FIG. 2. Comparison of the spines of *Astrophytum* plants from (A) Sierra Agua Chiquita, (B) Sierra de la Paila (var. *aureum*) and (C) west of Cuatro Ciénegas, Coahuila, Mexico.



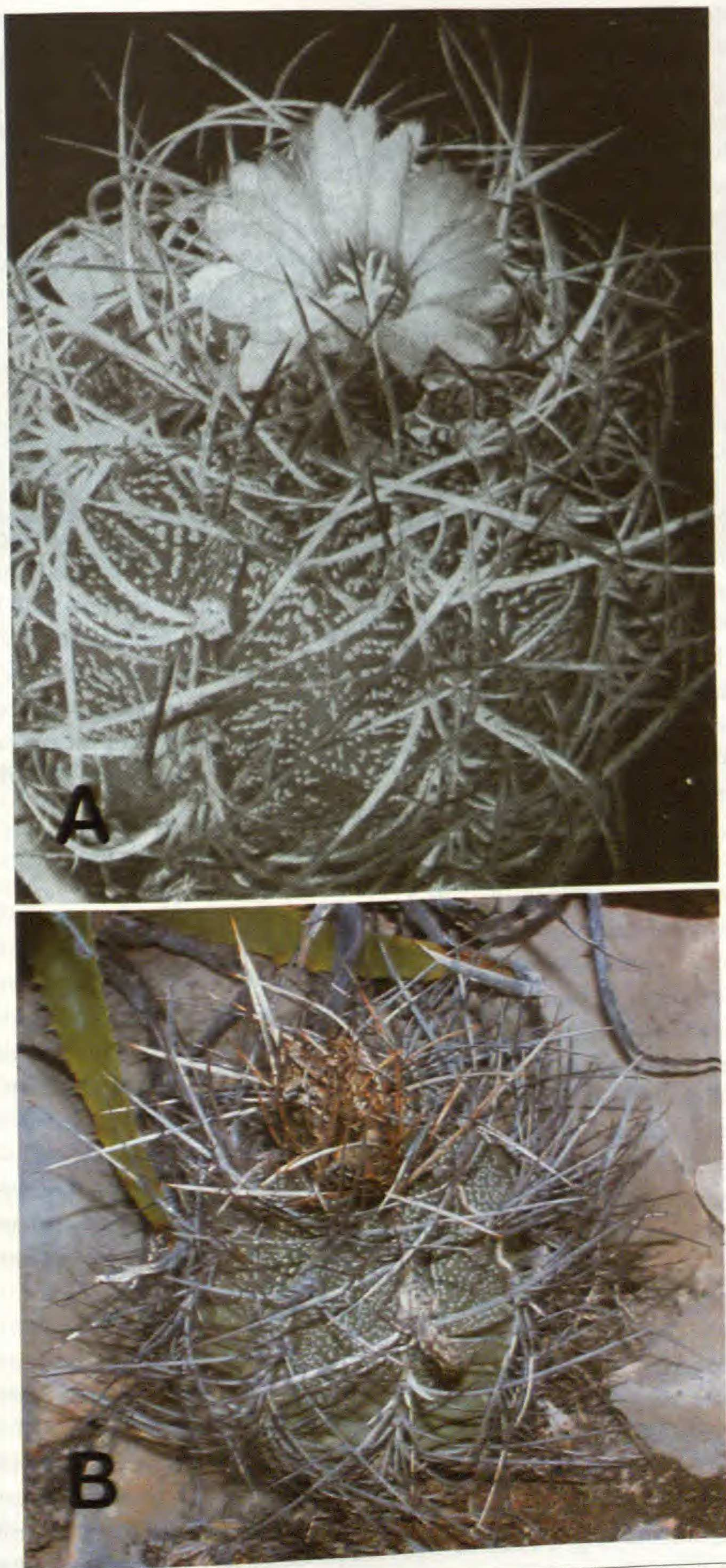


FIG. 3. Photo from (A) Haage and Sadovský (1957b) of var. "*crassispinum*," compared with a photo (B) by Werner Sporbert in Momberger (2007), showing the close similarity between the two plants. See text for further discussion.



the plant, with the tips curved upwards. The spines of the plants from the western bolson are very stout, somewhat flattened, and usually number from 6 to 8. Typically, the bottom pair is strongest and characteristically bowed to the left and right with the tips curved upwards. As mentioned previously, the spines are considerably stouter than those of plants from the Sierra Agua Chiquita population, and better fit the concept of the name "*crassispinum*." Apparently, Heinrich Möller was quite impressed by the thickness of the spines which he described. Also, he had in his possession at the same time var. *aureum* for the purpose of publishing a taxonomic description in the same paper (Möller 1925). His published descriptions are detailed, indicating that he had excellent knowledge of the comparative morphology of the two taxa. Momberger (2007) suggested that the name "*crassispinum*" is a misnomer which resulted in a misconception of the spine morphology of this taxon. However, Momberger's opinion is not supported by evidence. We note that the concept of the name is compatible with the detailed description of the spine morphology given by Möller (1925).

- 4) Möller's original description states that the throat color of the flower is sulfurous yellow. In plants from the western bolson, the throat varies from peach to orange or orange-red, and in relatively few specimens the throat color is pure yellow. Říha and Bušek (1986) reported that among a series of 12 plants, four plants (33.3%) had exclusively yellow throats; the remaining eight had red color in the center. These plants originated from seed material procured by A.B. Lau in 1977 from the western bolson. Heinrich Möller did not state how many blossoms he observed in the original plant material, and therefore it is not known if the flowers displayed variation comparable to that observed among the plants from the western bolson. It is possible that H. Möller observed flowers from a small subset of the original series of plants and thus was not aware of any color variation. Alternatively, the original plant material may have been collected from a colony in which yellow throat color was locally fixed. In any case, we regard the departure from the original description to be of minor significance considering that the variation of the population includes yellow throat color.

#### CONCLUSIONS

The plants from the Sierra Agua Chiquita described as var. *crassispinum* by Momberger (2007) differ by several significant morphological characters from Möller's original description of *crassispinum*. In the Sierra Agua Chiquita plants, the new spines have a yellow or straw color; the spines are relatively slender with an angular, triangular or rounded cross-sectional shape, and the population is comprised of sparsely flocked plants; completely nude plants have not yet been found. In contrast, the *Astrophytum* population from the western bolson (42 km W of Cuatro Cienegas) agrees quite closely with Möller's original description. The plants have new spines with a black-brown color; the spines are very stout with a slightly flattened cross-sectional shape; the bottom pair of spines is strongest, bowed to the left and right and standing away from the plant, with the tips curved upwards. Flower color is variable, but at least some plants in the population have a yellow throat. Entirely nude as well as sparsely flocked plants occur in the population. The primary discrepancy is the presence of heavily flocked plants at the location 42 km W of Cuatro Cienegas. We offer explanations for this discrepancy below.

The evidence presented above reveals that Momberger's designated neotype (ULM-18572) seriously conflicts with Heinrich Möller's original description of var. *crassispinum*. Therefore, we recommend that under the provisions of ICBN, Article 9.17b, the neotype (ULM-18572) be set aside and superseded by another element. It is our contention that neotypification is essential for taxonomic stability. The designation of another specimen as the neotype is warranted because there is apparently no surviving plant material from Möller's original description of 1925. Furthermore, the name *crassispinum* should be attached to a herbarium specimen in order to prevent any ambiguity with other known taxa or with new taxa potentially discovered in the future. Therefore, we here designate ZSS-019963 (Fig. 4) as the neotype of var. *crassispinum* for its morphology agrees with Heinrich Möller's original description.



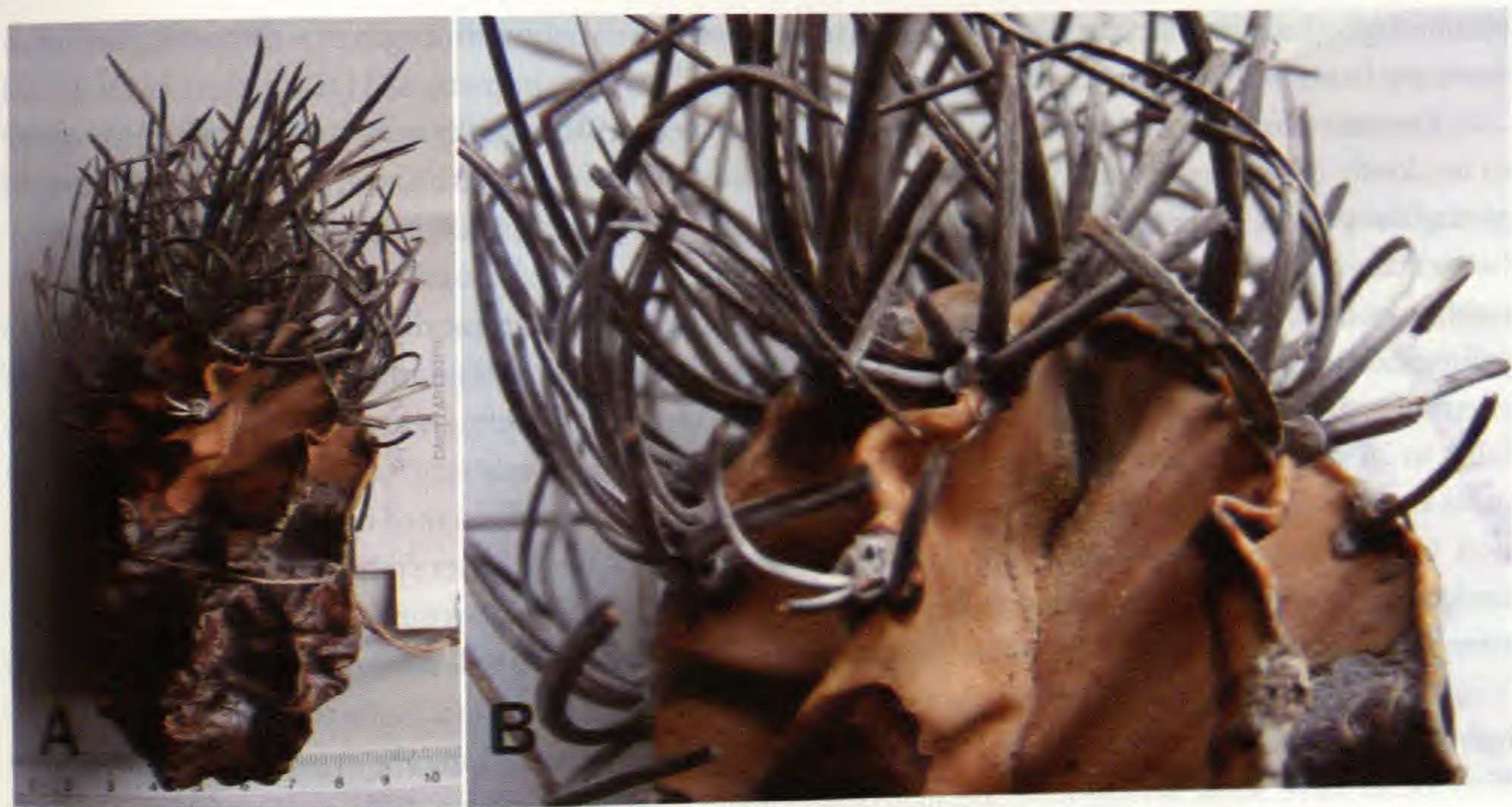


FIG. 4. The neotype (ZSS-019963) of *Astrophytum capricorne* var. *crassispinum* showing (A) the entire plant and (B) the close-up of spines.

#### REDESCRIPTION

***Astrophytum capricorne*** (A. Dietr.) Britton & Rose var. ***crassispinum*** (H. Möller) Okumura, Syaboten-no-Kenkyu 4:175. 1933. *Echinocactus capricornus* A. Dietr. var. *crassispinus* H. Möller, Z. Sukkulentenk. 2:129. 1925. TYPE: MEXICO, COAHUILA: cultivated plant without associated locality data, 42 km W of Cuatro Ciénegas de Carranza, ca. 1980s, Heinz Swoboda s.n. (original NEOTYPE, designated by Momberger 2007: ULM-18572; new NEOTYPE, here designated: ZSS-019963). Note.—The neotype is a cultivated plant without associated locality data. However, we have information that the collector, Heinz Swoboda, visited the habitat west of Cuatro Ciénegas around the 1980s (see also Pavlíček 2011). We tentatively restrict the type locality to 42 km west of Cuatro Ciénegas de Carranza, Coahuila, Mexico.

*Astrophytum capricorne* var. *crassispinum* f. *major* A.F. Möller, in Okumura, Syaboten-no-Kenkyu 5:103. 1934.

*Astrophytum capricorne* var. *crassispinum* f. *minor* A.F. Möller, in Okumura, Syaboten-no-Kenkyu 5:103. 1934.

A revised description of var. *crassispinum*, with additional morphological data from plants in cultivation and from the habitat, is herewith presented. Statistics of dispersion include the sample mean  $\pm$  two standard errors followed by the observed limits in parentheses.

**Description.**—Body single, young plants spherical, short columnar with age, pale to dark leaf green; stem up to 35 cm in height; epidermis nude or only sparsely flocked with white spots comprised of short hairs (triplicates). Ribs always 8, sharp-edged. Areoles  $\pm$  oval, ca. 6 mm in long diameter, 20 mm apart, with abundant chomes). Plant body surrounded by a loose tangle of yellowish to whitish hairs, later turning whitish gray and dingy. Spines (–5)6–8(–11) somewhat flattened, very stout, rather stiff, up to 85 mm long; new spines at apex black-brown, becoming gray-white with age. Bottommost pair strongest, bowed to the left and right, directed away from stem, with tips curved upward. Plants from west of Cuatro Ciénegas agree with this description of the spines although there is considerable individual variation (see photos in Říha & Bušek 1986). Flower diameter is  $77.8 \text{ mm} \pm 3.5 \text{ mm}$  (60–104 mm) in 44 flowers; ovary slender, covered with pointed scales; flower tube with abundant wool; perianth funnel-shaped; outer tepals acuminate, dirty yellow; inner tepals spatulate, denticulate, canary yellow and satiny; flower throat waxy, varies from peach to orange to orange-red to red, rarely sulfur-yellow or honey-brown; stamens barely half as long as corolla tube; filaments yellow, anthers slightly darker; style with  $7.5 \pm 0.3$  (4–12) yellow stigma lobes in 91 flowers. Fruit red or pale green with reddish base; dehiscence basal in circular fashion; seeds usually connected by funiculus at hilum to ovary; fresh fu-



niculus light pink, later drying. Seeds cap-shaped, 2.7 mm (2.5–3.0 mm) in length;  $n = 30$  seeds. Number of seeds per fruit: 146(96–280);  $n = 32$  fruit.

*Comparisons.*—Variety *crassispinum* and var. *niveum* are morphologically very similar and are presumed to be closely related sister taxa. Var. *niveum*, however, is densely covered with short, white hairs (trichomes), giving the plant a snow white and felted appearance. Also the plants are slightly larger, reaching 50 cm in height; maximum recorded height for *crassispinum* is 35 cm. As described above, var. *crassispinum* shows variation in the throat color of its flowers; in var. *niveum* the flower center is typically scarlet, but also rarely pure yellow (Schätzle 1988). The flower of var. *niveum* is similar in diameter and number of stigmata to that of var. *crassispinum*. Flower diameter is  $74 \text{ mm} \pm 4.4 \text{ mm}$  (60–80 mm) in 10 flowers; style with  $8.4 \pm 0.6$  (6–12) stigma lobes in 25 flowers. When the two varieties are compared at the same body size, var. *crassispinum* usually has more areoles with spines. The greater density of spines may help protect the naked epidermis from solar radiation. In var. *niveum*, the dense covering of trichomes may compensate for fewer spines by providing the necessary protection from solar radiation. In both varieties, there are uncommon forms in their respective populations which have new spines with a whitish to yellowish color (Říha & Bušek 1986).

*Remarks on Type Locality.*—The type locality for var. *crassispinum*, originally given as the Sierra de Parras, has been a source of controversy for many years inasmuch as plants matching the type description have not been found there. Some authors have speculated that Heinrich Möller may have deliberately misstated the type locality as a diversionary tactic (Říha & Bušek 1986). However, this seems improbable for a man of his professional standing; more likely, he would have simply withheld such information in the interest of plant conservation. Furthermore, in Möller's description of var. *aureum* (in the same article with var. *crassispinum*) the origin of the plants is correctly stated. His brother, Arthur Möller, would probably not have deliberately misled him about the type locality, for he had provided accurate locality information for other new taxa sent previously. It is possible that A. Möller inadvertently mislabeled the specimens or simply neglected to mention where they had been collected, leading Heinrich Möller to assume the plants originated from the Sierra de Parras which is relatively close to San Pedro.

The tentative restriction of the type locality deserves comment. Arthur Möller's collection of plants included both nude and sparsely flocked individuals in nearly equal proportions. Assuming he collected plants randomly from the habitat, the relative numbers of sparsely flocked and nude plants in his series would have corresponded to their relative abundance in the habitat. At the present time, the populations at 42 km west of Cuatro Cienegas are comprised primarily of nude plants (var. *crassispinum*) and densely flocked plants (var. *niveum*), with sparsely flocked plants being quite scarce. There are at least two possible explanations for the apparent discrepancy. If Möller collected his series at this locality, a natural change in relative abundance may have occurred since 1925 with the densely flocked plants increasing at the expense of the sparsely flocked plants (perhaps caused by a strengthening of an incipient reproductive isolating mechanism between the two varieties). The other explanation is that Arthur Möller collected his series from a different location, perhaps farther west or southwest and away from the densely flocked population. This would then account for the absence of *niveum*-like plants in the series he collected. In support of this possible explanation, we are aware of one undisclosed, distant locality where nude and sparsely flocked plants of var. *crassispinum* have been observed, but no examples of var. *niveum* have yet been found.

The extent to which var. *crassispinum* and var. *niveum* exchange genes in nature is unknown and merits detailed study. Baumann (1992) regarded the sparsely flocked plants as "intermediates" (presumed hybrids?) between the two varieties. We have produced sparsely flocked plants (as well as nude ones) by crossing two pure green plants, thereby demonstrating that they can arise through genetic recombination and are not necessarily  $F_1$  hybrids. Artificial  $F_1$  hybrids should be produced to determine the density of flocking on the epidermis. Also, var. *niveum* plants from 42 km W of Cuatro Cienegas should be inter-crossed to determine if any of the resulting seedlings are partly or completely devoid of pubescence.

*Taxonomic Remarks.*—As presently conceptualized, *Astrophytum capricorne* consists of approximately seven varieties; additional varieties may yet be described. As all of these taxa are treated equally as varieties



under the type species, the classification system does not accurately reflect their relationships and evolutionary history. Momberger (2011) has attempted to rectify this situation by the simultaneous use of the categories of "subspecies" and "variety" for some taxa. Whether this system will be well received or rejected by taxonomists remains to be seen.

In reviewing the descriptions of these taxa, we have determined that in some cases there are insufficient morphological data for proper taxonomic diagnosis. It is evident that the "*capricorne* group" is in need of careful study in order to determine the number of valid taxa, their rank, interrelationships and evolutionary history. Future research should include not only detailed morphological analysis, but molecular genetic analysis as well. In addition, the roles that physiographic features, viz. Desierto de Mayran, have played as vicariance factors in the evolution of the "*capricorne* group" members should be investigated.

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